

Safety of Pedestrian under Mixed Traffic Condition – A Review Study

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ABSTRACT: Walking, the most traditional mode of transportation, can carry a high risk of injury or death on many of our Nation's roads and highways. Motor vehicles only have been around for about a century, but during that comparatively short time, they often have made walking hazardous. Pedestrian crashes are a major safety concern worldwide, especially in India. About one of every ten traffic-related mortalities in the country is a pedestrian. Pedestrian accidents are usually the result of complex situations and the outcome of a number of aspects related to driver and pedestrian behaviour and road infrastructure. Safety depends mainly on how well the traffic condition is perceived and on visibility in traffic. This paper deliberates the results of a literature review of studies relating safety of pedestrian. An inclusive approach is required for improving road safety of pedestrians and reducing the casualties on the roads. In the similar direction this study tends to figure out various studies carried out in the world related to pedestrian safety on roads.

KEYWORDS: Pedestrian safety, Crashes, Critical Factors, Traffic accident, Mixed Traffic.

I. INTRODUCTION

With economic growth and increased urbanisation, many countries are experiencing transport-related problems as inherited transport infrastructure is unable to cope with increasing travel demand. These problems include an increased likelihood of crashes and severity of injury for unprotected road users, particularly pedestrians, due to their inherent vulnerability. Pedestrian safety is an important problem of global dimensions. A World Health Organization report describes traffic accidents as one of the major causes of death and injuries around the world, accounting for an estimated 1.2 million fatalities and 50 million injuries. In low-income countries, a large majority of deaths are not the vehicle occupants but the vulnerable road users (VRUs), consisting of pedestrians, bicyclists, two wheelers, and other small vehicles. In high-income countries, pedestrian fatalities are relatively lower but still represent large societal and economic costs to the nations.

Emphasis on highway transportation historically has focused on increasing the safety and mobility of motor vehicles; less attention has been given to pedestrians. The trend has begun to shift in recent years. Several detailed studies have been conducted on various aspects of pedestrian safety. These studies have attempted to quantify the magnitude and characteristics of pedestrian collisions and identify the traffic and roadway characteristics associated with such crashes.

Every day thousands of pedestrians are killed and injured on roads. Men, women or children walking, biking or riding to school or work, playing in the streets or setting out on long trips, will never return home, leaving behind shattered families and communities. Millions of people each year will spend long weeks in hospital after severe crashes and many will never be able to live, work or play as they used to do. Road traffic injuries constitute a major public health and development crisis, and are predicted to increase if road safety is not addressed adequately.

II. LITERATURE REVIEW

Pedestrian safety is a problem all over the world. Each year numerous pedestrians die or get severely injured in traffic accidents. The majority of accidents occur in urban areas. The reason for this is the constant interaction between vehicles and pedestrian. Accidents come with a great cost for the victim and for the society. Speed plays a central role in traffic safety, more and more traffic researchers come to that conclusion. The present section presents the past studies related to the study.

Pei et.al. (2012), studied the effect of exposure and speed on crashes in Hong Kong. Results indicated a positive correlation between speed and crash risk when distance exposure is considered, and negative when time exposure is used. However, speed was found positively associated with the injury severity [1].

Mustakim and Fujita (2011), developed accident predictive models based on the data collected at rural roadway, Federal Route 50 Malaysia. Multiple non-linear regression method was used. The result verified that, the existing number of major access points, without traffic light, rise in speed, increasing number of AADT, growing number of motorcycle and motorcar and reducing the time gap are the potential contributors of increment accident rates on multiple rural roadways. National Cooperative Highway research program, NCHRP, TRB, US, has done a very exhaustive work to suggest multivariate models were lane width, shoulder width, no of intersections and number of horizontal curves were considered as significant variables [2].

Mohan (2011) analysed the data reported by Asian countries and demonstrated that a few high-income countries have unreliable statistics, and on the other hand a few low-income countries were able set up good data collection systems. Overall and road user specific fatality rates do not have a high correlation with country income levels. The reasons for this are not known. In the absence of more reliable data and identification of risk factors for each country, it is not possible to give very specific country-based countermeasures for road safety. It would be adequate at present to focus on measures that have international validity and are known not to have negative side-effects [3].

Charles (2010) claimed that as automobile transportation continues to increase around the world, bicyclists, pedestrians, and motorcyclists, also known as Vulnerable Road Users (VRU), will become more susceptible to traffic crashes, especially in countries where traffic laws are poorly enforced. Several countries, however, are employing innovative strategies to ensure that road users can more safely navigate the urban landscape. This research addressed the potential countermeasures and strategies for improving pedestrian safety from an international perspective [4].

Najamuddin and Parida (2004) from their study claimed that pedestrians are the main victim of fatal accidents. Nearly 90 % of the total fatalities in our country occur on rural roads while only 10 percent occur on urban roads. Traditional planning is greatly biased to the motorized modes of transport, even though every road user is a pedestrian at some stage of journey. The problem had always been realized but efforts are mostly negligent. Therefore, the researchers suggested the need to address it within an integrated system of roads, road users and vehicles. The researchers also claim that Pedestrian traffic safety needs to be addressed within an integrated system of roads, road users and vehicles. In comparison to developed countries the traffic accident characteristics and nature of accidents are considerably different in India. To enhance the road safety condition, a large number of strategies can be employed. Traditional planning is greatly biased to the motorized modes of transport. A comprehensive traffic and transport study focus on large public transport system and undermines the importance of operating a safe pedestrian transport network. Although a number of urban transport studies have been completed in India still pedestrian facilities have not received their due emphasis [5].

Kumar and Kulkarni (2010) through their research said that Pedestrians are neglected because they make no noise. They go quietly finding their ways in prevailing chaos. A recent study conducted in Indian Cities states that more than 20% of the road accidents involve pedestrian. Hence safety of pedestrian is a basic step to create safer city. A report entitled "Road Safety in India: Challenges and Opportunities" March 2009 states that road traffic fatalities have been increasing at about 8% annually for the last ten years. About 60% of all fatalities in urban areas belong to pedestrians. Hence pedestrian safety is a challenge for transport planners, traffic engineers, town planners, urban local bodies and policy makers to make city safer [6].

Anthaput and Got (2012) acclaimed that in the age of rapid motorization, the pedestrian has been left far behind. Huge investments are directed towards building infrastructure for motorized modes, while little or no planning is provided to non-motorized modes of travel such as walking and cycling, which have been the traditional modes of travel. Increased urban sprawl, improved economic conditions and neglect of pedestrian facilities have all led to increase in the number of motorized vehicles, which have resulted in our cities with high levels of pollution, congestion, road accidents, social inequality, poor mobility, and deterioration of quality of life. Asian cities are set to explode with over 55% of population projected to live in them by 2030. This poses a huge challenge to the concept of sustainability [7].

Sharma and Landge (2012) studied that pedestrians are one of the Vulnerable Road User, have become more susceptible to traffic crashes with the rapid growth of motor vehicles in India. In terms of pedestrian crashes on a worldwide scale over 4, 00,000 pedestrians are killed every year and over 10,000 pedestrians are killed on Indian roads. To date, only limited research has been undertaken to develop the accident prediction model for pedestrian accidents. The research focus on pedestrian crash prediction model on Indian Rural Highway (NH-6). Accident data collected between 2005-09 over a stretch of 100 km of road length are used for modelling. The Negative Binomial method was used to model the frequency of accident occurrence. The Akaike Information Criterion (AIC) is used to measure the

relative goodness of fit. The candidate set of explanatory variables are: Total Traffic volume (AADT), Lane width (LW), Shoulder width (SW), and access density (AD). It is observed that access density, Shoulder width and Lane width have significant impact on pedestrian safety [8].

Singh & Suman (2012) selected a stretch of NH-77 from Hajipur to Muzaffarpur. The accidental data was collected for last eleven years, 2000-2010 from the Police Stations where FIR was lodged. The collected data were analysed to evaluate the effect of influencing parameters on accident rate. Heavy vehicles like truck are involved in maximum number of accidents on the selected stretch. It was estimated that a heavy vehicle is involved in almost 48% accidents followed by two-wheelers 16%, car 12% and bus 10%. There was no definite trend for monthly variation in accident on a study section but the accidents in month of July and January are generally higher. Accident rate in terms of number of accidents per km-year increases with traffic volume. But the accident rate in terms of number of accidents per million-vehicle kilometre-year (MVKY) decreases with increase in traffic volume. Accident rate per MVKY increases during the study year, whereas both injury and fatality rate per MVKY show a declining trend over the study period. The developed model for accident prediction represents that the number of accidents per-km-year increases with AADT and decreases with improvement in road condition [9].

Kouabenan and Guyot (2004) used three methods to analyse 55 reports of actual pedestrian accidents randomly selected from police records in the Ivory Coast. Each method revealed a particular aspect of pedestrian accident causation according to accident severity. An analysis of the spontaneous causal explanations given by the involved persons made it clear that pedestrians and drivers explain accidents in a defensive way by stressing factors that tend to incriminate the other party. In the conclusion, we point out the utility of an approach that combines several methods of accident analysis and we consider some ways to improve the use of accident reports for prevention purposes [10].

Steve Mark (2001) studied the increasing concern with the growing number of pedestrians struck by motor vehicles. The research addresses vehicles with bumpers at a pedestrian's thigh height, such as vans and sport utility vehicles. The goal of the research was to predict upper leg form forces due to bumper impacts and analyse bumper system concepts for minimizing these forces [11].

Naughton and Cate (2001), studied an approach to a solution to conflicts of interest posed by new pedestrian safety requirements are presented here. The effects of various design parameters on pedestrian safety and the resulting influence on other requirements were examined. Computer Aided Engineering (CAE) techniques are used extensively for this work, in order to determine the sensitivity of the behaviour of front-end systems to design and material characteristics. Finally, an overall approach to solutions is presented, involving a theory of stiffness distribution to meet the pedestrian safety requirements, while continuing to address the current needs [12].

Yoshiuki, Mizuno and Hirotoishi Ishikawa (2001), studied the IHRA pedestrian working group has conducted investigation and analysis on the current status of pedestrian accidents in the IHRA member countries. The researchers collected the accident data that occurred by 1999, then unified the formats of the accident data and established a dataset that makes it possible to make comparison with each other. As per the status of pedestrian accidents, three parts of the pedestrian's body have the highest priority for protection, the child and adult heads, and the adult lower leg/knee. The study further suggested that it was deemed necessary to conduct validation study of the test procedures through actual tests using sample vehicles and to explore the car feasibility level prior to the use of the test methods in legislation [13].

FACTORS CONTRIBUTING TO PEDESTRIAN SAFETY

Built-In Environment: Pedestrian crash risk is multi-factored. Crashes vary significantly by location and time complicated further by their statistical rareness and largely randomness in relation to being able to predict an occurrence. Urban cores commonly comprise mix-land use, diversity of trip purposes, and dispersed walking trip linkages [14]. The main urban road, which is usually classified as an arterial road or collector road, dominates the concentration of pedestrians and vehicle volumes. Zegeer and Bushell [15] explain that the number of pedestrian crashes is more likely to occur in areas with a higher population and road crossing movements. Pedestrians' risk of death in these zones is 10 times higher than car occupants [16]. In fact, Jacobsen remarked that vehicle-pedestrian crashes are less likely when the number of cycling or walking in particular areas increased. In an environment that prioritised pedestrians rather than vehicular modes, such as self-explaining roads or mixed-use shared spaces, a road function can influence road users' manoeuvres and safety outcomes. [17] These environments, if appropriately implemented, can create a safe, user-friendly place for vulnerable road users to dominate the primary space function, resulting in fewer crash events [18]. However, a key issue is that self-explaining roads or shared space roads cannot be implemented on all road types, especially arterial and collector roads when high through movement is prioritised.

Pedestrian Behaviour: Pedestrians and vehicle interactions are common at road crossings where sharing the right of way creates a greater potential of conflict and, therefore, a higher risk of crash involvement. In most cases, the casualty can be examined from road rule compliance. Studies indicate that the lack of adherence to the traffic regulations from both drivers and pedestrians is one of the critical factors associated with pedestrian crashes [19]. King et al. [20] reported that the relative risk of non-compliance crossing was eight times higher than in legal crossings at signalised intersections. Collisions from road rule violation may aggravate the situation, particularly when involved with high-speed vehicles. Várhelyi [21] stated that only one in four drivers would lower their speeds or brake when they are encountering pedestrians who are on or about to step onto the zebra crossing, and most of them did not prepare to reduce speed for unexpected situations. Pedestrians are unprotected road users and as such are significantly more likely to sustain greater injury severity with increased relative vehicle conflict speeds. The provision of controlled pedestrian crossings is believed to enhance the safety and mobility of pedestrians, but it does not always guarantee road user's (pedestrian and driver) compliance. Studies reveal the counterintuitive evidence that the presence of pedestrian crossing facilities is found not to be significant and seems to create a false sense of safety in some situations. Pedestrians are more likely to be impatient when the waiting time increases or crossing during the red signal phase seems easy. Non-compliance behaviour is, therefore, considered as one of the key factors associated with increased crash risk.

Pedestrian Characteristics: There is evidence that elderly road user groups have a higher fatality rate in traffic environments than average road users. Additionally, the consequences of injuries to the elderly can be more severe [22]. Several countries reported that half of the road toll was among this group, and the proportion was relatively high in urban areas [23]. In addition, due to the increased number of the ageing population worldwide, a challenge of road safety policies is to ensure safer mobility of the elderly. Road users who are alcohol-impaired is another group that shows a disproportionately high share in road crashes [24] in the USA indicated that almost 48% of crashes in 2015 were pedestrian fatalities that involved some alcohol impairment from both drivers and pedestrians. The trend is similar in Sweden, where pedestrians with alcohol involvement showed a higher crash risk, and this constituted between 39% and 60% of pedestrian crashes. Charlton and Starkey (2013) in New Zealand indicated that alcohol consumption resulted in cognitive impairment such as visual attention, vigilance, and driving tasks when a BAC level reaches 0.08% [25]. Distraction by electronic devices using mobile phones or music players among road users does not currently present as a primary contributing factor to pedestrian crashes. This is most likely due to under-reporting problems due to the difficulty of obtaining real causality factors. However, an upward trend in mobile phone use while driving poses a higher likelihood of crashes.

III. CONCLUSION

Pedestrians are the most vulnerable road users, and therefore, they require maximum protection on the road. The large number of fatalities and injuries show the importance of developing pedestrian protection systems. This paper discussed the global nature of the pedestrian safety problem and the initiatives taken by research groups to address it. It provided a comprehensive understanding of various issues, approaches, and challenges in improving pedestrian safety, including a comparative discussion of different approaches that have been developed recently. Pedestrian protection systems offer many important research problems to work on, such as development of different types of sensors, processing of sensor information to extract relevant features, analysis and classification of these features to detect and track pedestrians, behaviour and intent analysis of drivers and pedestrians, as well as human factors and interfaces. Methods described in the former section can help to improve pedestrian safety and decrease pedestrian accidents after finding effective factors and providing pedestrian accident prediction model on roads under study.

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